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system and a comparison of it with [illegible] Thorenson system will be given.

Finally a considerable improvement in the already improved read around ratio will be observed [illegible] explanation.

II DESCRIPTION OF THE [illegible]

In order to study the [illegible] time following the first pulse, a three beam system was devised. The beam is first turned on at the storage spot for about two microseconds. Then it is moved abruptly to an adjacent spot about one spot diameter, displaced, leaving the beam on during the move. The beam is left on for three microseconds at this location. During this three microseconds the output of the amplifier is sampled at a level of about 25% of the peak positive excursion of the signal at this time. The information is returned to the spot by positioning the [illegible] and turning it on again for [illegible]. Figure 2 shows the pulses for a dot, (a) and a dash, (b), [illegible]. It should be noticed that one is actually taking the positive excursion at this point. The height of this pulse in the case of a dot is obtained principally by the amount of charging necessary to charge the second spot, which is discharged in the case of a dash. However, it also is partially determined by the collapse of the space charge present at the first spot. Thus the output information is partially taken from both spots. The truth of this statement is further brought out by the observed fact that with this system, it has been found to be possible to cause failures both from dots

to dashes and dashes to dots with equal probability, until the address of bad read around ratio conditions.

This system was first successfully tested on a six position test memory which is normally used for testing static and dynamic storage cathode ray tubes. This memory has circuitry necessary for read around ratio which automatically tests each of the cells addressed for read around ratio failure. Read around ratio's from [illegible] may be used. Possible test values rise in steps of 2. The test consists of filling the entire memory with dots, selecting one address, writing a dash in a place of that address, each write is being followed by a regeneration cycle [illegible] from the test address, and then checking the entire memory for bad or dash failures. This process is repeated a number of times for each address in sequence in the memory. The number of times it is which the tested tube fails to make an error or less is the read around ratio of that tube. The [illegible] value [illegible] the read around ratio achieved with the normal [illegible] system and with the newly devised system described in the following [illegible] memory regeneration circuits in both tests.

POSITION NO.	[illegible]
0	[illegible]
1	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	[illegible]

[illegible]

these tests will be repeated until [illegible] This is because the probability of the two tests [illegible] test done, it may be used as [illegible] deal with dots only about the [illegible]. This [illegible] correct on the high plus by [illegible]

On the basis of this [illegible] to use this system. On the [illegible] around write and [illegible] much as possible. [illegible] failures would [illegible] during read around write tests, [illegible] failures, one for dot [illegible]

In order to clarify the explanation, a dot will be defined as a spot which gives output signals which indicate a read one, only briefly after the beam is first turned on. A dash will be defined as a spot which gives a positive rising output which remains. The tests proceed in the following manner. Only the dot to dash failing pattern is described since the dash to dot failing pattern is similar with the exception of the change of checking for failures.

The routine is given in half of the memory. The other half of the memory is filled with dots (that is, read one, that the beam will be on as long as possible to test the effect of read around on times). Then an address in the field of dots is selected. The neighboring eight addresses are changed to dashes (which may already all be in this case). Then the control address is recorded n times with a dot where n is the read around ratio value being tested. After this the eight addressed are checked for failure. If no failure occurs a new address is selected and the process repeated. If a failure occurs, the address of the bombarded spot and the test pattern are typed out and then the test proceeds as though it had not failed. When every address in half of the memory has been tested, the routine is transferred to the opposite half of the memory and the area previously occupied by the routine is tested. Before starting all n dots at a value of, the number n is read in from the input tape and printed out for reference. The tested values of the read around ratio thus are placed in sequence on the input tape and the machine uses them in order. The program can test to values as high as

256 in steps of 8. [illegible] access and since the [illegible] with the memory speed, the value of [illegible] memory would ever be [illegible]

Previous to the [illegible] the maximum value of the read around ratio [illegible] was from 20 to 25. This occurred [illegible] field of dashes, [illegible] addresses were from dots to [illegible] no failures occur on any of the [illegible] dashes to dots is between [illegible] need be given by the user of the [illegible] very severe cases.

III QUALITATIVE EXPLANATION OF THE FULL GUARD BAND DEVELOPMENT

Figures 1, 2, and 3 [illegible] in three Williams tube [illegible]. Figure 1 is a [illegible] normal Williams system. Figure 2 is a similar set of waveforms for the Thorenson variation. Figure 3 is an [illegible] system. The most significant set of curves is that of $\frac{dq}{dt}$, the net electron current toward the screen as a function of time, since that is more or less the quantity sensed at the input to the amplifier. It should be emphasized that these curves are only correct qualitatively and probably are accurate only in polarity since it is difficult to view the quantity directly. The curves are more or less self-explanatory, the cause for each peak being

indicated on the drawing. It will be noted that the output signals follow the $-\frac{\partial q}{\partial t}$ curve quite closely except for a partial inspection caused by the input circuit to the amplifier and of course a reversal of sign since $\frac{\partial q}{\partial t}$ is sensed rather than $\frac{\partial q}{\partial t}$.

Considerably more is known about the Williams system and the ILLIAC memory than can be related here thoroughly. In fact, it was from observation of the output signals of these systems that the $\frac{\partial q}{\partial t}$ curves were evolved. However, an experimental test of the true Thompson system was made and the wave forms check quite closely. As yet, little can be said about the read around ratio results except that they seem at least to promise all that of the ILLIAC system at first glance both theoretically and experimentally.

The advent of the much improved read around ratio has led to a reconsideration of what occurs under conditions of poor read around ratio. It has been concluded that the disrupting effect of stray secondaries is much less severe than had been supposed. With reasonable read around ratios, (on the order of 50), it is felt that the actual change in voltage at a normally charged spot is small. The difficulty that seems to arise, though, is that by sensing at the first pulse following the turning on of the sampling beam, the maximum perturbation is found. At this time the first result is that the sampling beam recharges the spot back to its normal equilibrium value. Then a space charge is formed. This means that the disturbing effect of this recharging process fails at the precise time that is almost universally chosen to perform the sensing of the output information from the amplifier. Therefore, of its disturbing influence

is ever to be felt. It will be [illegible] read around ratio may be [illegible] the charged spot may not have [illegible] then seem to indicate that a [illegible] time would be desirable as was [illegible] Thorenson.

With the [illegible] discharging of the second [illegible] ratio. Since the same effect will occur there with this system as is described above for the normal system it is quite likely that the true Thorenson system will yield better results. It is interesting to note, though, that the possibility of causing flaws and read around ratio to fail in the same direction, namely from dots to dashes, exists. It has been observed to be relatively easy to reverse the direction of failure by either changing the sensing level of the [illegible]. This would allow the novel possibility of finding flaws and read around ratio failures with the same type of test, especially since [illegible] also diminishes flaw amplitude. It would then be possible to sample the output in such a manner as to try to avoid both read around ratio difficulties and flaws at the same time.

With regard to the Thorenson system, it should be mentioned that in order to properly sense the difference between dots and dashes at the point indicated in Figure 2, it is necessary that the signals go negative with respect to the baseline of the time of sensing. This negative region arises due to the formation of a space charge about the first spot after that spot is regenerated by the sampling beam. It therefore

must be remembered that [illegible] in order that this condition can be realized in time due to the charging time. Since the capacity ratio is not at all affected by refill and since the signal [illegible] is considerably larger here than earlier, the read around ratio [illegible].

IV EXPERIMENTAL EVIDENCE

In order to check the theories [illegible] conditions of severe read around ratio in the ILLIAC system, a sensing circuit employing a cathode coupled amplifier was built. This circuit reacted by giving a positive going pulse when the output voltage from the amplifier went to 1/2 of the read positive excursion of a dash but did not return to its zero position state until the amplifier delivered a voltage equal to [illegible] of the peak. Using this circuit it was observed that [illegible] read around ratios were encountered, the circuit switched to its zero state earlier and earlier in time. However, although the [illegible] earlier, it was observed that they did not fall until about the same time as the positive peaks on normal dots fell. This then indicates that it is better to sense the presence of a dot later in time when it is reliably positive.

In order to further check the theories for the improved read around ratio, a system was designed applying the same pulse sequence was used as in the ILLIAC system but sensing took place at the normal positive dash time. The indicated read around ratio was even poorer than with the normal system. This then indicates that the improvement is due to the sensing time and not to the external beam turn on arrangement or any

special and possibly [illegible]

V CONCLUSIONS

From these [illegible] that the read-around ratio is actually due to the [illegible]. Further, the re-distribution effects of [illegible] been previously suggested. Also [illegible] to be possible to improve the read-around ratio [illegible] by varying the sensing time. If the data were [illegible] to be distributed almost to deshes, the output signals for these ones would approach very closely to the standard dash signals at all points in the wave form since there would be no significant difference between pulses for very poor data and it would be very difficult [illegible] the difference at any point in time.

The change to a [illegible] which it is felt may actually be more desirable, [illegible] on the ILLIAC since its use would involve [illegible] of the logical circuits of the forty regeneration channels now in use.

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